Bedrock Geology ...and Your Community

Getting Started

Except for a few sudden, dramatic events in your lifetime, you will probably notice very little change in the physical features of the Earth around you. However, the rock record in your community will likely tell a long and complicated story. Therefore, geologists must understand the processes that form and shape rocks in order to "read the story" and reconstruct the past. Reconstructing the past is important, because unraveling the past can help you understand how the planet works.

- What are the three major types of rocks, and how do they form?
- How old are the oldest rocks on Earth?
- How old are the oldest rocks in your community, and how did they get there?

What do you think? Write down your ideas about these questions in your *EarthComm* notebook. Be prepared to discuss your ideas with your small group and the class.

Scenario

The Bed and Breakfast Association in your community would like to provide their guests with geological information about the region in which they are located. They know that visitors come to the area to explore the surroundings. They have asked the *EarthComm* students in your school for help. They need your study and report of the geologic history of your community to provide to tourists. Can you use your understanding of rocks to teach the public about the geologic history of your state? Can you develop a brochure or guide which the Bed and Breakfast Association in your community can actually use? Perhaps you might wish to work with other schools in your area or your state to develop a report that can be used over a wider region.

Chapter Challenge

Your challenge is to write a report about the geologic history of your area to be used by the Bed and Breakfast Association in your community. The report should:

- Give an accurate summary of the geologic history of your state.
- Help people understand the rocks and sediments in your state and community.
- Describe principles of Earth science as they relate to geologic change.
- Explain how your local geologic history fits into the geologic history of the United States and North America.

Here are some ideas for you to think about. Choose one that is most practical for your class and your community.
Road Log: Geology seen along a highway (or series of highways).
Trail Guide: Geology seen along a hiking or biking trail.
Park Brochure: Geology of local or state parks.

Assessment Criteria

Think about what you have been asked to do. Scan ahead through the chapter activities to see how they might help you to meet the challenge. Work with your classmates and your teachers to define the criteria for assessing your work. Record all this information. Make sure that you understand the criteria as well as you can before you begin. Your teacher may provide you with a sample rubric to help you get started.

Activity 1 Sedimentary Rocks and the Geologic History of Your Community

Goals

In this activity you will:

- Identify and classify several sedimentary rocks.
- Describe how the three main types of sedimentary rocks form.
- Understand that sedimentary rocks are divided into groups based on how they form.
- Infer the environment in which sediment was deposited when you are given a sedimentary rock.
- Understand that classification helps scientists organize the natural world into smaller, workable components.

Think about It

Sedimentary rocks, which are made of sediment, cover about three-fourths of the Earth's land surface.

- How does sediment "turn into" sedimentary rock?

What do you think? Record your ideas about this question in your *EarthComm* notebook. Include a quick sketch. Be prepared to discuss your responses with your small group and the class.

Investigate

Part A: Making Models of Sedimentary Rocks

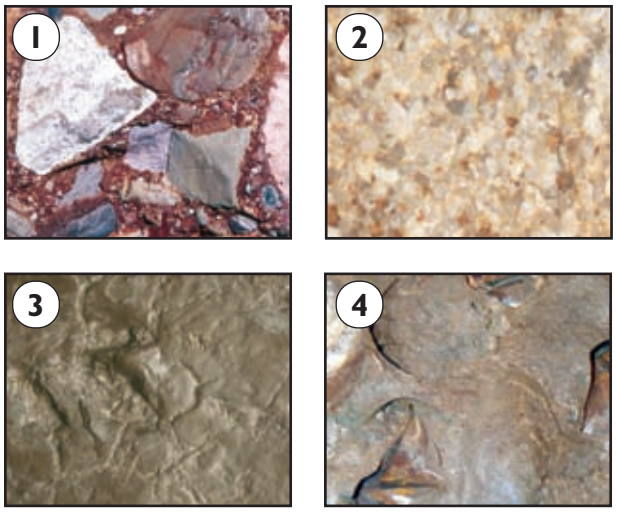
1. Mudstone
   - Spread some wet mud in a pan.
   - Set it out in the sun undisturbed until all the moisture has evaporated from the mud.
2. Rock Salt
   - Add salt to a container of warm water until salt will no longer dissolve.
   - Pour a few millimeters of the water into a shallow plate, dish, or pan.
   - Let the water evaporate overnight. Do not disturb the setup until all the water has evaporated.
3. Sandstone
   - Make a mixture of half water and half white craft glue.
   - Combine this mixture with a handful of sand in a small container. Pour off any excess liquid.
   - Line a small bowl or beaker with waxed paper and pour in the sandy mixture.
   - Let it stand undisturbed until all the water has evaporated, which may take several days.
4. Conglomerate
   - Make a mixture of half water and half white craft glue.
   - Combine this mixture with a handful of sand, gravel, and clay in a small container. Pour off any excess liquid.
   - Line a small bowl or beaker with waxed paper and pour in the sandy mixture.
   - Let it stand undisturbed until all the water has evaporated, which may take several days.
5. Sediment deposition
   - Pour a mixture of clay, silt, sand, and gravel in water into a clear, unbreakable container.
   - Close and shake the container, then let it stand.
   - Observe the container over the next several days.

   a) Describe what you observe immediately, by the end of class, and the next day.
6. Examine the rock samples that you made. These samples are models of sedimentary rocks.

   a) Draw a labeled diagram of each sedimentary rock that you made.

Clean up spills immediately.
Take care not to get sediments into your eyes.
Wash your hands after you have completed the activity.

Part B: Observing Sedimentary Rocks



1. Obtain a set of sedimentary rocks. Common sedimentary rocks include limestone, dolomite, mudstone, sandstone, siltstone, shale, conglomerate, rock salt, and coal. Carefully observe and describe the rock samples.
   a) Make a data table to record your descriptions of each sedimentary rock. Note any distinguishing features.
   b) The three major sedimentary rock types are described below. Based on your descriptions, determine the sedimentary rock type of each rock sample.

Sedimentary Rock Type	Description
Clastic	Fragments of rocks and minerals that have been physically transported and deposited and then converted into rock.
Organic	Remains of plants and animals that have been converted into rock.
Chemical	Direct precipitation of minerals from a solution.

Part C: Sedimentary Rocks of Your Community

1. Examine the legend of a geologic map of your community or local area or state. A geologic map shows the distribution of bedrock at the Earth's surface. The bedrock shown on the map might be exposed at the surface, or it might be covered by a thin layer of soil or very recent sediment. Every geologic map has a legend that shows the kinds of bedrock that are present in the map area. The legend also shows the rock bodies or rock units that these rocks belong to, and their geologic age. You will learn more about rock units in Activity 4 of this chapter.

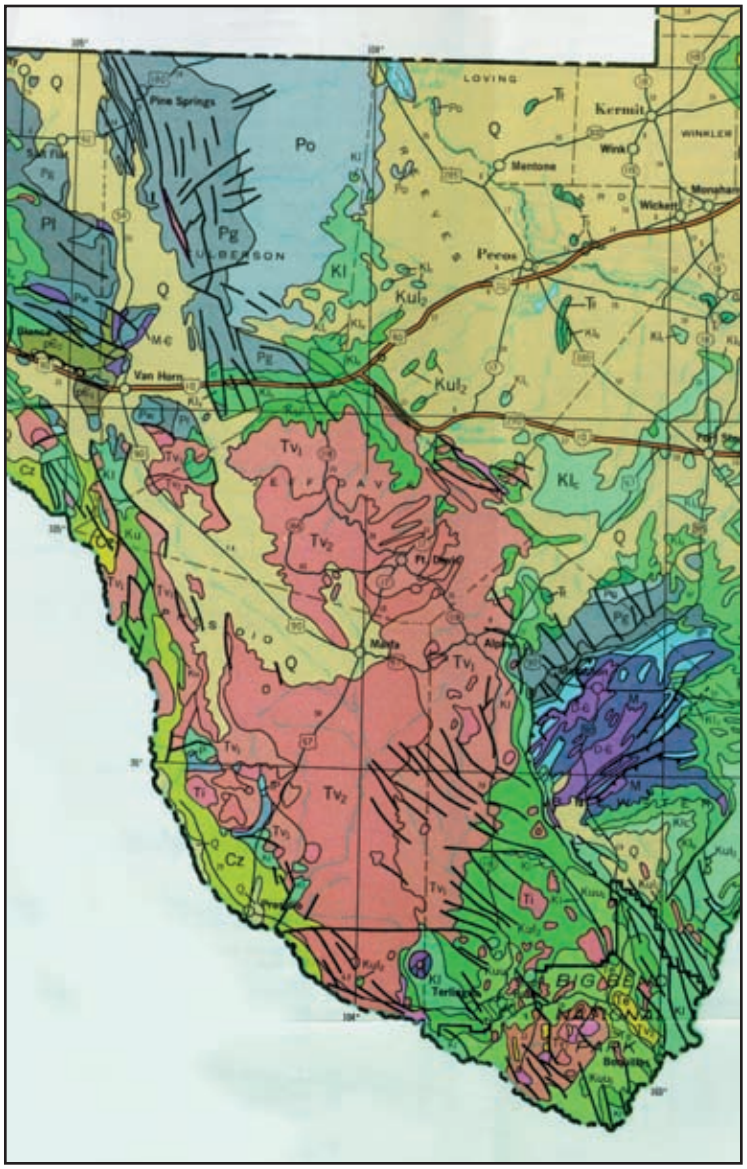
Working with your group, interpret the data on the geologic map by answering the following questions:

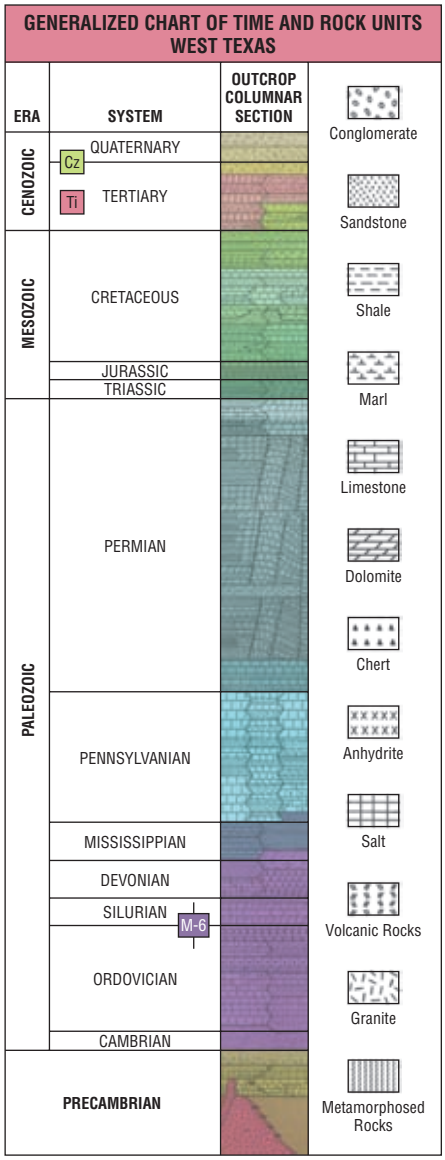
a) Are any sedimentary rocks described in the legend? If yes, write down the rock types, the names of the rock units they belong to, and their locations.

b) What are the most common sedimentary rocks in your area?

c) Which is the oldest sedimentary rock unit?

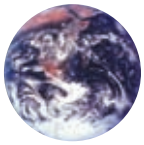
d) Which is the youngest sedimentary rock unit?





Reflecting on the Activity and the Challenge

In this activity, you made models of sedimentary rocks and used these models to help you identify sedimentary rocks. You also interpreted sources of information about sedimentary rocks in your area. Being able to identify sedimentary rocks will help you understand how and where sedimentary rocks are formed. This information will help you to understand the geologic history of your community and help you to complete your Chapter Challenge.



Digging Deeper

SEDIMENTARY ROCKS IN THE EARTH'S CRUST

Distribution of Sedimentary Rock

Except for a thin layer of soil and very young sediments at the Earth's surface, the Earth's crust is made of solid **bedrock**. The crust consists of a very wide range of rock types, but **sedimentary rocks** are by far the most common rock type in the upper part of the crust. If you could somehow remove the thin layer of soil and sediment from the top of the crust and look at the exposed bedrock, about three-quarters of it would be sedimentary rock. Over large areas of the continents, sedimentary rocks form layers, as shown in *Figure 1*.

Figure 1 The Grand Canyon is a striking example of layering in sedimentary rocks.

In areas near the ocean, sedimentary layers usually indicate that those areas were below sea level at certain times in the past. In the middle of a continent, the presence of sedimentary layers generally means one of two things. The area might have been topographically low relative to nearby mountain ranges, which supplied **clastic sediments** to cover the low area. The other possibility is that the area was covered by a shallow sea in the past. Either clastic sediments or chemical sediments can be deposited in a shallow sea, depending upon the nature of the nearby land areas and the chemistry of the seawater.

Geo Words

bedrock: solid rock that is connected continuously down into the Earth's crust, rather than existing as separate pieces or masses surrounded by loose materials.

sedimentary rock: a rock, usually layered, that results from the consolidation or lithification of sediment, for example a clastic rock like sandstone, or a chemical rock like rock salt, or an organic rock like coal.

clastic sedimentary rock: a sedimentary rock made up mostly of fragments derived from pre-existing rocks and transported mechanically to their places of deposition.

Clastic Sedimentary Rocks

Clastic sedimentary rocks are made of fragments, called **clasts**, that are eroded from other rocks. Conglomerate, sandstone, siltstone, mudstone, claystone, and shale are clastic sedimentary rocks. Clasts are classified according to their size. The smallest clasts, too small to see without a microscope, are called clay, and clasts with sizes between clay and sand are called silt. Claystone consists of clay-size particles, and siltstone consists of silt-size particles. Mudstone consists of a mixture of silt-size and clay-size particles. When a claystone or mudstone breaks into small, flat chips, it is often called a shale. Sandstone is made of sand-size particles. Conglomerate is made of gravel-size particles, which range from small pebbles to large boulders. The size of the particles usually reflects the strength of the medium that carried the sediment. Pieces of gravel are much larger than tiny clay particles, so faster flows of water are needed to move them from where they originate to where they are deposited.

Chemical Sedimentary Rocks

When water cannot hold all of the material that is dissolved in it, some of the material comes out of solution as solids. This process, which is called **precipitation**, commonly happens when some or all of the water evaporates, or when the water is cooled. **Chemical sedimentary rocks** consist of materials that have precipitated from ocean water or lake water, as shown in *Figure 2*.

Figure 2 Evaporation of rainwater produces salt flats, as in Death Valley.

Geo Words

clast: an individual fragment of sediment produced by the physical disintegration of a larger rock mass.

precipitation: the process of forming solid mineral constituents from a solution by evaporation.

chemical sedimentary rock: a sedimentary rock formed by direct chemical precipitation of minerals from a solution.

Geo Words

organic sedimentary rock: a sedimentary rock consisting mainly of the remains of organisms.

In Part A of the investigation, you modeled the deposition of a chemical sediment by allowing a saturated saltwater solution to dry. The salt crystals that formed precipitated out of the solution. Limestone is the most common chemical sedimentary rock. It consists of the mineral calcite, a calcium carbonate mineral with the formula $CaCO_3$. Some of the calcium carbonate is precipitated directly out of sea water, and some of it is precipitated by marine animals to make their shells. Dolomite is another common chemical sedimentary rock. It consists of the mineral dolomite (with the same name as the rock!), with the chemical formula $CaMg(CO_3)_2$. Gypsum ($CaSO_4 \cdot 2H_2O$), and halite (NaCl), also called rock salt, are also precipitated out of solution. They form when evaporation concentrates the dissolved material enough for it to precipitate out of solution. Areas where intense evaporation is most likely to happen are those with arid (dry) climates.

Organic Sedimentary Rocks

Some sedimentary rocks are made of organic materials. Coal is the best example. Coal forms when plants in swamps with rich vegetation die and are buried by the remains of later plants. Over time, the plant material is compacted so much by the weight of overlying sediment that it is turned into rock. The first material to form is called peat. Peat, shown in *Figure 3*, which has not yet been buried deeply, is used by humans for fuel and for agriculture. With time and greater compaction, peat is converted to lignite ("brown coal") and, with further compaction, bituminous coal ("soft coal"). Approximately 35 m of original plant matter is compacted to form one foot of bituminous coal. The most deeply buried coal is called anthracite ("hard coal").

Figure 3 In Ireland, peat harvested from bogs is often used as a source of fuel.

Sedimentary Environments

Sedimentary rocks are formed from sediments that are deposited in various environments at the Earth's surface. Limestone, for example, is usually deposited in a shallow ocean. Sandstone can also be deposited in a shallow ocean, but it can also form in a beach environment, a desert environment, or a river environment. Coal is usually formed in swamps. A sedimentary rock can therefore tell you something about what the environment was like when and where the sediment was deposited. Each rock tells a story about the geologic environment in which it formed. It may not be easy, however, for geologists to read that story!

Sedimentary Rocks and Climate

Sedimentary rocks can give you information about past climates. For example, sandstone that was deposited as desert sand dunes records a time when the area was dry and lacking protective vegetation. Limestones suggest deposition in warm, shallow oceans. Coal forms in tropical to subtropical climates. Ancient coal is found in Antarctica. This suggests that climate has changed over time in the Antarctic.

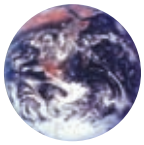
How Sediment Becomes Rock

In many places where sediment deposition continues for a long time, the sediments become buried deep below the Earth's surface. The pressure on the sediment increases, causing the particles to be pressed together. Also, water solutions filtering up through the pore spaces of the sediment from deeper in the Earth tend to precipitate cementing material around the sediment particles. These processes of **compaction** and **cementation** cause the sediment to be converted into a solid sedimentary rock. In Part A of the activity, your mixture of glue and water modeled the natural cementation process. Clastic sediments usually turn into solid rock after

Geo Words

compaction: the reduction in bulk volume or thickness of fine-grained sediments owing to increasing weight of overlying material that is continually being deposited.

cementation: the process by which sediments are converted into rock by the precipitation of a mineral "cement" among the grains of sediment.



Check Your Understanding

1. What does the presence of sedimentary rock layers reveal about sea level or past topography in a region?
2. Why is gravel more likely to be found on a river bottom than on a lake bottom?
3. The top of Mt. Everest is made of limestone. What does this suggest about how the topography of that area has changed through time?
4. Rock salt is mined throughout the Great Lakes region. What does this suggest about the past climate of this area?

many hundreds, or even thousands, of meters of burial. Chemical sediments, on the other hand, can become sedimentary rocks with very shallow burial of meters to a few hundreds of meters.

Classifying Sedimentary Rocks

The great variety of sedimentary rocks stems from the variety of environments where sediments are deposited. Classification, or the grouping or ordering of objects by similar features, is meant to make it easier for people to think about and discuss what they are investigating. Classification schemes reflect the features that the observer considers to be important. When you looked at the sedimentary rocks, you made judgments about how to put them into groups. Each person or group that makes a classification system decides which features form the basis of classification. For example, you might have chosen color, texture, roundness of grains, or other features. Did you find differences in your groups or between groups? If you did, you would have experienced exactly what geologists experienced when they developed classification systems for sedimentary rocks. The classification of sedimentary rocks described in this activity (clastic, chemical, and organic) is about the simplest scheme that can be used. Sedimentary geologists have developed much more detailed classifications that stem from this simple one. The main features that are used in such classifications are the composition of the sediment particles and the size of the sediment particles.

Understanding and Applying What You Have Learned

1. In your own words, explain how the three main types of sedimentary rocks form.
2. From your knowledge of sedimentary rocks, label the following interpretations of depositional environments as true or false. Explain your answers.
   a) Coal and peat form from the same material.
   b) Limestone indicates that a shallow sea once covered an area.
   c) The presence of sandstone indicates that the area was once a shoreline.
   d) Rock salt indicates that a region once had an arid climate.
   e) Claystone is deposited by fast-flowing streams.
3. Look at the three rock samples shown in the photographs or provided to you by your teacher.
   a) What is the name of each of the sedimentary rocks?
   b) Describe a possible depositional environment in which each formed.
   c) How did the models you made help you identify these rocks?